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Transmitted herewith for filing is the patent application of

Inventor(s): Kazutaka Hanaoka, Yuichi Inoue,
Seiji Tanuma and Makoto Ohashi

For: DRIVING OF A LIQUID CRYSTAL
        DISPLAY DEVICE

Enclosed are:
(X)   _20_ pages of specification, including _16_ claims and an abstract.
(X)   an executed oath or declaration, with power of attorney.
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(X)   _8_ sheet(s) of informal drawing(s).
( )   ____ sheet(s) of formal drawings(s).
(X)   Assignment(s) of the invention to Fujitsu Limited.
(X)   Assignment Form Cover Sheet.
(X)   A check in the amount of $_40.00_ to cover the fee for recording the assignment(s)
       is enclosed.
( )   Information Disclosure Statement.
( )   Form PTO-1449 and cited references.
( )   Associate power of attorney.
(X)   Priority Document.

Fee Calculation For Claims As Filed

a)	Basic Fee						$ 760.00
b)	Independent Claims	2	- 3	=	0	x $ 78.00	= $_____
c)	Total Claims	16	- 20	=	0	x $ 18.00	= $_____
d)	Fee for Multiple Claims					$260.00	= $_____
					Total Filing Fee		$ 760.00

( )   ____ Statement(s) of Status as Small Entity, reducing Filing Fee by half to $_____

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( )   Charge $_____ to Deposit Account No. 07-2069.

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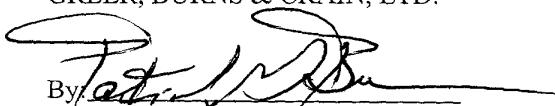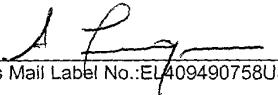
SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, Kazutaka Hanaoka, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan, Yuichi Inoue, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan, Seiji Tanuma, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan and Makoto Ohashi, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan have invented certain new and useful improvements in

DRIVING OF A LIQUID CRYSTAL DISPLAY DEVICE

of which the following is a specification : -

1   TITLE OF THE INVENTION
          DRIVING OF A LIQUID CRYSTAL DISPLAY DEVICE

     BACKGROUND OF THE INVENTION
5   The present invention generally relates to
     liquid crystal display devices and more particularly
     to the driving of an active-matrix liquid crystal
     display device in which representation of images is
     achieved by applying a driving voltage to a liquid
10   crystal layer via a thin-film transistor (TFT).
          Liquid crystal display devices have various
     advantageous features such as compact size, light
     weight, low power consumption, and the like. Thus,
     liquid crystal display devices are used extensively in
15   portable information processing apparatuses such as
     lap-top computers or palm-top computers. Further,
     liquid crystal display devises are used also in desk-
     top computers in these days.
          A typical liquid crystal display device
20   includes a liquid crystal layer confined between a
     pair of glass substrates and achieves representation
     of images by inducing a change in the orientation of
     liquid crystal molecules in the liquid crystal layer
     by applying a driving voltage to the liquid crystal
25   layer. Such a change in the orientation of the liquid
     crystal molecules causes a change in the optical
     property of the liquid crystal layer.
          In the case of using such a liquid crystal
     display device in a high-resolution color
30   representation apparatus, there is a need of driving
     the individual pixels or liquid crystal cells defined
     in the liquid crystal layer at a high speed. In order
     to meet this requirement, it is generally practiced to
     provide a thin-film transistor in correspondence to
35   each of the pixels in the liquid crystal layer and to
     drive the liquid crystal cells by way of such thin-
     film transistors.

1   FIG.1 shows the construction of a liquid
crystal panel 10 used in such an active matrix liquid
crystal display device of a related art in a plan
view, while FIG.2 shows the part circled in FIG.1 in a
5   cross-sectional view.

Referring to FIG.2, the liquid crystal panel
10 generally includes a pair of glass substrates 10A
and 10B, and a liquid crystal layer 10C is confined
between the substrates 10A and 10B.

10   As represented in the plan view of FIG.1,
the glass substrate 10A carries thereon a number of
thin-film transistors 11_1 - 11_4 corresponding to the
pixels in a row and column formation, wherein the
thin-film transistors 11_1 and 11_2 aligned in the row
15   direction are connected commonly to a gate bus line G_1
provided directly on the glass substrate 10A.
Similarly, the thin-film transistors 11_3 and 11_4 are
connected commonly to a gate bus line G_2 provided
directly on the glass substrate 10A. Further, the
20   glass substrate 10A carries thereon a number of
generally H-shaped auxiliary electrodes Cs at the
level of the gate bus lines G_1 and G_2, wherein the
auxiliary electrode Cs is covered by an insulation
film 12 as represented in the cross-sectional view of
25   FIG.2, and data bus lines D_1 and D_2 are formed on the
insulation film 12 so as to extend in the column
direction as represented in the plan view of FIG.1.

It should be noted that the data bus lines
D_1 and D_2 are covered by another insulation film 13 as
30   represented in the cross-sectional view of FIG.2, and
the data bus line D_1 is connected to the respective
source regions of the thin-film transistors 11_1 and
11_2 via a conductor pattern branched from the data bus
line D_1. Similarly, the data bus line D_2 is connected
35   to the respective source regions of the thin-film
transistors 11_2 and 11_4 via a conductor pattern
branched from the data bus line D_2.

1   Further, there is provided a rectangular pixel electrode of a transparent conductor such as ITO on the insulation film 13 in correspondence to the drain region of each of the thin-film transistors.

5   For example, the drain region of the thin-film transistor 11_1 is connected to a transparent pixel electrode P_1 provided on the insulation film 13 via a contact hole formed in the insulation film 13. As can be seen from FIGS.1 and 2, the auxiliary electrode Cs

10   is disposed at both sides of the data bus line D_1 or D_2 when viewed in the direction perpendicular to the substrate 10A, such that the electrode Cs overlaps the edge part of the transparent pixel electrode P_1 or P_2. Thereby, the auxiliary electrode Cs forms an auxiliary

15   capacitor together with the transparent pixel electrode P_1 or P_2.

      Further, each of the transparent pixel electrodes P_1 and P_2 is covered by a molecular alignment film 14, wherein the molecular alignment

20   film 14, contacting directly with the liquid crystal layer 10C, induces an alignment of the liquid crystal molecules in the liquid crystal layer 10C in a predetermined direction.

      The opposing substrate 10B, on the other

25   hand, carries a color filter CF in correspondence to the foregoing transparent pixel electrode P_1 or P_2, and a transparent opposing electrode 15 of ITO, and the like, is provided uniformly on the substrate 10B. It should be noted that the transparent opposing

30   electrode 15 is covered by another molecular alignment film 16, and the molecular alignment film 16 induces an alignment of the liquid crystal molecules in the liquid crystal layer 10C in a desired direction. Further, the substrate 10B carries thereon an opaque

35   mask BM in correspondence to a gap between a color filter CF and an adjacent color filter CF.

      FIG.3 shows an example of the driving signal

1   supplied to the data bus line D_1 or D_2 when driving the liquid crystal panel 10 of FIGS.1 and 2.

      Referring to FIG.3, a bipolar driving pulse signal is supplied to the data bus line from a driving

5   circuit, wherein it should be noted that the bipolar driving pulse signal changes a polarity thereof between a positive peak level of $+V_D$ and a negative peak level $-V_D$ during the black mode of the liquid crystal panel 10 for representing a black image.

10   Further, a predetermined common voltage V_{CS} is supplied to the opposing electrode 15 and the auxiliary electrode Cs from another D.C. voltage source during the black mode. In the white mode of the liquid crystal panel 10 for representing a white

15   image, on the other hand, on the other hand, a bipolar drive pulse signal having an amplitude smaller than a predetermined threshold voltage is supplied to the foregoing data bus line D_1 or D_2.

      It should be noted that the foregoing D.C.

20   voltage source for supplying the common voltage V_{CS} is provided as an independent unit independent from the driving circuit used for driving the data bus line D_1 or D_2. The D.C. voltage source provides a voltage of $_\Delta V_C$ as the foregoing common voltage V_{CS}, wherein the

25   common voltage V_{CS} thus set is slightly offset from the central voltage V_C of the bipolar driving pulse signal. It should be noted that the liquid crystal panel 10 of FIG.1 or 2 uses a low voltage liquid crystal, characterized by the black mode drive voltage

30   V_D of about 5 V or less, for the liquid crystal layer 10C.

      In the liquid crystal panel 10 driven as such, it should be noted that the optimum common voltage V_{CS} changes slightly between the black

35   representation mode and the white representation mode. More specifically, the optimum common voltage V_{CS} coincides substantially with the central voltage V_C of

1   the bipolar driving pulse signal ($\triangle$Vc = 0) in the
black representation mode, while the optimum common
voltage deviates from the central voltage Vc ($\triangle$Vc $\neq$ 0)
in the half-tone or white representation mode. As the
5   common voltage V_{CS} is applied uniformly to the
opposing electrode 15, it is difficult to change the
common voltage adaptively depending on the content of
the image to be represented. Thus, it has been
practiced to fix the common voltage V_{CS} to the optimum
10   voltage at the time of the half-tone representation
mode.

Meanwhile, the inventor of the present
invention has noticed, in a liquid crystal panel using
a low voltage liquid crystal for the liquid crystal
15   layer 10C, that there appears a noticeable flicker in
the represented images along the edge part of the
auxiliary electrode Cs. In the investigation that
constitutes the foundation of the present invention,
the inventor has studied this phenomenon and
20   discovered that the flicker is caused as a result of
variation of the disclination which is induced in the
liquid crystal layer 10C in the region including the
data bus line D_1 or D_2 and the auxiliary electrode Cs
by a strong lateral electric field.

25   FIGS.4A and 4B show the alignment of the
liquid crystal molecules in the liquid crystal layer
10C and the electric flux of the lateral electric
field applied to the liquid crystal layer for the case
in which the common voltage V_{CS} applied to the
30   auxiliary electrode Cs and the opposing electrode 15
is offset from the central voltage of the bipolar
driving pulse signal (V_{CS} $\neq$ Vc, wherein FIG.4A shows
the state in which a voltage of +5V is applied to the
data bus line D_1 or D_2 (represented as "D"), while
35   FIG.4B shows the state in which a voltage of -5V is
applied to the data bus line D.

Referring to FIG.4A, it can be seen that a

1   very large lateral electric field is created between
the data bus line D and the adjacent auxiliary
electrode Cs in the state the voltage of +5V is
applied to the data bus line D. Associated with this,

5   there occurs a conspicuous disturbance in the
molecular orientation or disclination in the liquid
crystal layer 10C in correspondence to the part
between the data bus line D and the auxiliary
electrode Cs. As a result of the formation of such a

10   disclination, there is induced a domain structure in
the liquid crystal layer 10C, and a leakage of light
occurs in correspondence to the boundary of the
domains as represented in FIG.4A by arrows.

    In the state of FIG.4B in which a voltage of

15   -5V is applied to the data bus line D, on the other
hand, the lateral electric field applied to the liquid
crystal layer 10C is substantially reduced and there
occurs no substantial formation of domain structure or
associated problem of leakage of the light. As the

20   state of FIG.4A and FIG.4B appears alternately in
correspondence to the polarity of the bipolar driving
signal pulse, the leakage light appearing only in the
state of FIG.4A causes the flicker.

    Further, the inventor of the present

25   invention has discovered that there occurs a flow of
the liquid molecules in the liquid crystal layer 10C
in the rubbing direction of the molecular alignment
film when the value of the common voltage V_{Cs} of the
auxiliary electrode Cs is deviated from the central

30   voltage of the bipolar driving pulse signal. When
such a flow occurs in the liquid crystal layer 10C,
there occurs an increase in the thickness of the
liquid crystal layer 10C in correspondence to the part
where the liquid crystal molecules are accumulated.

35   When there occurs such a change in the thickness of
the liquid crystal layer 10C, the optical property of
the liquid crystal panel 10 is modulated also.

1 Further, in the case a low-voltage liquid
crystal is used for the liquid crystal layer 10C,
there tends to occur a sticking of images as a result
of the accumulation of impurity ions associated with
5 the flow of the liquid crystal molecules. It should
be noted that such a low-voltage liquid crystal,
characterized by a low driving voltage, is
particularly vulnerable to contamination.

10 SUMMARY OF THE INVENTION
  Accordingly, it is a general object of the
present invention to provide a novel and useful
driving method of a liquid crystal display device
wherein the foregoing problems are eliminated.
15 Another and more specific object of the
present invention is to provide a method of driving a
liquid crystal display device, said liquid crystal
display device comprising: a first substrate; a second
substrate opposing said first substrate with a gap
20 therebetween; a liquid crystal layer confined in said
gap; a thin-film transistor formed on said first
substrate; a conductor pattern formed on said first
substrate in electrical connection with said thin-film
transistor, said conductor pattern supplying an
25 alternate-current driving voltage signal to said thin-
film transistor; a pixel electrode provided on said
first substrate in electrical connection to said thin-
film transistor; an auxiliary electrode formed on said
first substrate in the vicinity of said conductor
30 pattern so as to form an auxiliary capacitance with
said pixel electrode, said auxiliary electrode being
disposed so as to induce a lateral electric field
between said auxiliary electrode and said conductor
pattern; and an opposing electrode formed on said
35 second substrate;
  said method comprising the step of:
  applying to said auxiliary electrode a

1   common voltage substantially equal to a central
     voltage of said alternate-current driving voltage
     signal.

          Other objects and further features of the
5   present invention will become apparent from the
     following detailed description when read in
     conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10   FIG.1 is a diagram showing the construction
     of a liquid crystal display panel of a related art in
     a plan view;

          FIG.2 is a diagram showing the construction
     of the liquid crystal display device of FIG.1 in a
15   cross-sectional view;

          FIG.3 is a diagram showing the waveform of a
     driving signal used in the liquid crystal display
     device of FIGS.1 and 2;

          FIGS.4A and 4B are diagrams showing the
20   electric flux line and the alignment of the liquid
     crystal molecules in a liquid crystal layer used in
     the liquid crystal display panel of FIGS.1 and 2;

          FIG.5 is a diagram showing the construction
     of a liquid crystal display device according to a
25   first embodiment of the present invention in a block
     diagram;

          FIGS.6A and 6B are diagrams showing the
     electric flux line and the alignment of the liquid
     crystal molecules in a liquid crystal layer used in
30   the liquid crystal display panel of FIG.5;

          FIG.7 is a diagram showing the possible
     range of an optimum common voltage according to the
     first embodiment of the present invention;

          FIG.8 is a diagram showing the waveform of
35   another driving voltage signal according to a second
     embodiment of the present invention; and

          FIG.9 is a diagram showing the optimum

1   common voltage corresponding to the driving voltage
signal of FIG.8 according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS
5   [FIRST EMBODIMENT]

FIG.5 shows the construction of a liquid
crystal display device 20 according to a first
embodiment of the present invention, wherein those
parts corresponding to the parts described previously
10   are designated by the same reference numerals and the
description thereof will be omitted.

Referring to FIG.5, the liquid crystal
display device 20 includes, in addition to the liquid
crystal panel 10 described previously with reference
15   to FIGS.1 and 2, a scanning-electrode driving circuit
21 for selectively activating the gate bus lines G_1 -
G_n and a signal electrode driving circuit 22 for
supplying the A.C. driving signal explained with
reference to FIG.3 to the data bus lines D_1 - D_m, and
20   there is further provided a D.C. voltage source 23
supplying the common voltage V_{cs} to the opposing
electrode 15 and to the auxiliary electrode Cs as a
common voltage supply source. FIG.5 further indicates
a capacitor PIXEL, wherein it should be noted that the
25   capacitor PIXEL represents the capacitance formed
between the transparent pixel electrode P_1 or P_2 and
the transparent opposing electrode 15.

The liquid crystal display device 20 of
FIG.5 is a so-called low-voltage liquid crystal
30   display device and the signal electrode driving
circuit supplies a bipolar driving voltage pulse
signal similar to the one shown in FIG.3 to the data
bus lines D_1 - D_m with an amplitude of ±5V.

In the present invention, the inventor has
35   discovered that the formation of the disclination
becomes substantially the same in the state in which a
driving voltage pulse of +5V is applied to the

selected data bus line D_1 - D_m and in the state in
which a driving voltage pulse of -5V is applied to the
selected data bus line D_1 - D_m, by setting the common
voltage V_{Cs} supplied from the common voltage source
23, to be equal to the central voltage (0V) of the
bipolar driving voltage pulse signal. As a result,
although the leakage of the light itself is not
eliminated, the flicker of the leakage light is
successfully eliminated. Further, it was discovered
that, by setting the voltage V_{Cs} as set forth above,
the sticking of images caused as a result of the flow
of the liquid crystal molecules in the liquid crystal
layer 11C, is also suppressed successfully.

FIGS.6A and 6B show the electric flux in the
liquid crystal layer 10C for the case in which the
common voltage V_{Cs} is set to 0 V.

Referring to FIGS.6A and 6B, it can be seen
that, although the disclination formation in the
liquid crystal layer 10C by the lateral electric field
is not avoidable, the degree of the disclination in
the liquid crystal layer 10C is more or the same in
the state of FIG.6A in which a driving voltage pulse
of +5V is applied to the selected signal electrode D_1
- D_m and in the state of FIG.6B in which a driving
voltage pulse of -5V is applied to the selected signal
electrode D_1 - D_m. As a result, there occurs no
substantial flicker in the light that has leaked
through the liquid crystal display device.

Further, as a result of the reduced
disclination formation in the liquid crystal layer 10C
caused by the foregoing setting of the common voltage
V_{Cs}, the flow of the liquid crystal molecules is also
reduced. As a result, the problem of thickness
increase in the liquid crystal layer 10C and
associated problem of local accumulation of the
impurity ions in the liquid crystal layer 10C are
effectively reduced. Thus, the present invention

1   reduces the sticking of images in the liquid crystal display device 20 of FIG.5 by setting the common voltage V_{CS} to be equal to 0V.

      FIG.7 shows the flicker formation in the

5   liquid crystal panel 10 having a 12-inch diagonal size for the case in which the common voltage V_{CS} is changed variously, wherein FIG.7 represents the flicker formation represented in terms of a domain fluctuation DF defined as

10

$$DF = (B_p - B_n)/B_p \times 100 \ (B_p > B_n),$$

      where B_p represents the leakage of light during the positive frame interval in which a positive drive

15   voltage pulse of +5V is applied, while B_n represents the leakage of light during the negative frame interval in which a negative drive voltage pulse of -5V is applied. Further, FIG.7 represents the thickness increase observed for the liquid crystal

20   layer 10C of the liquid crystal display device 20 of FIG.5, wherein the thickness increase was measured at a point offset from the right upper corner of the 12-inch panel 10 by a distance of 2cm in the lateral direction and 2cm in the longitudinal direction. The

25   measurement was made after 20 minutes of operation.

      Referring to FIG.7, it can be seen that the domain fluctuation, and hence the flicker formation, increases with increasing deviation of the common voltage V_{CS} from the central voltage of the bipolar

30   driving voltage pulse. Further, it can be seen that there appears a liquid crystal flow in the panel diagonal direction along the rubbing direction of the molecular alignment film 14, wherein the liquid crystal flow appears particularly conspicuously in the

35   black representation mode in which the amplitude of the driving voltage pulse signal applied to the liquid crystal panel 10 becomes maximum. As a result, the

1   cell thickness of the liquid crystal layer 10C is also
increased. As explained already, such an increase in
the liquid crystal cell thickness tends to invite an
accumulation of impurity ions contained in the liquid
5   crystal, and the contamination of the liquid crystal
by such an accumulation of the impurity ions induces a
conspicuous sticking in the represented images.

    In FIG.7, it can be seen that, in a region A
in which the deviation Δ_C of the common voltage V_{CS} is
10   less than about 0.025V, in other words in the region A
in which the foregoing deviation ΔV_C is less the about
1/20 of the voltage amplitude (5V) of the drive
voltage pulse, the domain fluctuation DF is less than
about 10% and no substantial sticking of images is
15   recognized. On the contrary, in a region B in which
the foregoing deviation ΔV_C exceeds 0.25V but is
smaller than about 2V, a linear sticking was
recognized. Further, in a region C in which the
deviation ΔV_C exceeds about 2V, the domain fluctuation
20   exceeds 50% and a considerable flicker is recognized.
Further, the thickness increase of the liquid crystal
layer 10C reaches as much as 0.025 µm. In this case,
the liquid crystal molecules are caused to flow in the
liquid crystal layer 10C with a velocity such that the
25   liquid crystal molecules move by a distance of more
than 80 µm during the interval of 24 hours.

    From the foregoing, it is preferable to set
the common voltage V_{CS} in the region B in which the
deviation ΔV_C with respect to the amplitude center of
30   the bipolar driving pulse voltage signal is less than
about 50% of the maximum voltage amplitude for the
black representation mode, more preferably in the
region A in which the deviation ΔV_C is less than about
10%. In the region B, it should be noted that the
35   liquid crystal molecules in the liquid crystal layer
10C moves over a distance of 80 µm or less during the
interval of 24 hours.

1   It should be noted that the foregoing result
         is not only pertinent to the liquid crystal panel of
         the 12-inch size but is applicable also to general
         liquid crystal panels having a diagonal size of 10 -
5   13 inches.

         [SECOND EMBODIMENT]
               In the foregoing embodiment, it was assumed
         that the drive voltage pulse signal supplied to the
10   data bus lines D_1 - D_m is a bipolar voltage pulse
         having a central voltage of 0V. The present
         invention, however, is never limited to such a
         particular driving signal but is applicable to the
         case in which the driving voltage pulse signal
15   includes a D.C. voltage offset as represented in
         FIG.8.
               Referring to FIG.8, the driving voltage
         pulse signal has a voltage amplitude of ±2.5V in the
         black representation mode, and the driving voltage
20   pulse signal is supplied to the data bus line D_1 - D_m
         together with a D.C. offset of 2.37V. Thereby, an
         optimum common voltage V_{cs} of 2.37V, which is
         substantially equal to the foregoing D.C. voltage
         offset, is applied to the auxiliary electrode Cs and
25   to the opposing electrode 15.
               In the driving process noted above, it
         should be noted that the optimum common voltage V_{cs}
         may be different in the black representation mode and
         in the white representation mode. In the example of
30   FIG.8, the common voltage V_{cs} optimized for the case
         in which the amplitude of the driving voltage pulse
         signal is set smaller than the threshold voltage of
         image representation, does not coincide with the
         common voltage V_{cs} of 2.37 V optimized for the black
35   representation mode. In fact, the optimized common
         voltage for the foregoing case takes a value of 2.42V
         rather than 2.37V. FIG.9 represents the relationship

1 between the optimum common voltage V_{CS} and the
gradation level for two different liquid crystal
panels A and B.

In view of the fact that the common voltage
5 V_{CS} is applied to the entirety of the liquid crystal
panel, it is difficult to change the optimum common
voltage V_{CS} adaptively depending on the gradation
level to be represented. In the present invention,
therefore, the optimum common voltage V_{CS} is optimized
10 for the black representation mode in which the flow of
the liquid crystal molecules in the liquid crystal
layer 10C appears most significantly.

In the description heretofore, the present
invention is described with reference to the so-called
15 H-type Cs liquid crystal panel represented in FIGS.1
and 2. However, the present invention is by no means
limited to such a specific construction of the liquid
crystal panel but is applicable to other liquid
crystal panels such as "independent Cs type" or
20 "Cs-on-gate type."

Further, the present invention is not
limited to the embodiments described heretofore, but
various variations and modifications may be made
without departing from the scope of the invention.
25

1   <u>WHAT IS CLAIMED IS</u>

5

    1.   A method of driving a liquid crystal
display device, said liquid crystal display device
comprising: a first substrate; a second substrate
opposing said first substrate with a gap therebetween;

10   a liquid crystal layer confined in said gap; a thin-
film transistor formed on said first substrate; a
conductor pattern formed on said first substrate in
electrical connection with said thin-film transistor,
said conductor pattern supplying an alternate-current

15   driving voltage signal to said thin-film transistor; a
pixel electrode provided on said first substrate in
electrical connection to said thin-film transistor; an
auxiliary electrode formed on said first substrate in
the vicinity of said conductor pattern so as to form

20   an auxiliary capacitance with said pixel electrode,
said auxiliary electrode being disposed so as to
induce a lateral electric field between said auxiliary
electrode and said conductor pattern; and an opposing
electrode formed on said second substrate;

25   said method comprising the step of:
    applying to said auxiliary electrode a
common voltage substantially equal to a central
voltage of said alternate-current driving voltage
signal.

30

    2.   A method as claimed in claim 1, wherein
35   said common voltage is deviated from said central
voltage by an amount corresponding to 2/5 or less of
an amplitude of said alternate-current driving voltage

1   signal set so as to provide a maximum gradation level.

5
          3. A method as claimed in claim 1, wherein
     said common voltage is deviated from said central
     voltage by an amount corresponding to 1/20 or less of
     an amplitude of said alternate-current driving voltage
10   signal set so as to provide a maximum gradation level.

15   4. A method as claimed in claim 1, wherein
     said central voltage is substantially zero volt.

20
          5. A method as claimed in claim 1, wherein
     said central voltage is offset from zero volt.

25

          6. A method as claimed in claim 1, wherein
     said common voltage is set such that a fluctuation of
     a leakage light, caused by a disclination induced in
30   said liquid crystal layer by a lateral electric filed,
     is 10% or less.

35
          7. A method as claimed in claim 1, wherein
     said common voltage is set such that a flow of liquid

1   crystal molecules, caused in said liquid crystal layer
by a disclination induced in said liquid crystal layer
by a lateral electric field, has a velocity of 80 μm
or less per an interval of 24 hours.

5

        8. A liquid crystal display device, said

10   liquid crystal display device comprising: a first
substrate;
      a second substrate opposing said first
substrate with a gap therebetween;
      a liquid crystal layer confined in said gap;

15   a thin-film transistor formed on said first
substrate;
      a conductor pattern formed on said first
substrate in electrical connection with said thin-film
transistor;

20   a driving circuit supplying an alternate-
current driving voltage signal to said thin-film
transistor via said conductor pattern;
      a pixel electrode provided on said first
substrate in electrical connection to said thin-film

25   transistor;
      an auxiliary electrode formed on said first
substrate in the vicinity of said conductor pattern so
as to form an auxiliary capacitance with said pixel
electrode, said auxiliary electrode being disposed so

30   as to induce a lateral electric field between said
auxiliary electrode and said conductor pattern;
      an opposing electrode formed on said second
substrate; and
      a direct-current source applying, to said

35   auxiliary electrode, a common voltage substantially
equal to a central voltage of said alternate-current
driving voltage signal.

1   9. A liquid crystal display device as
claimed in claim 8, wherein said direct-current source
produces said common voltage such that said common
voltage is deviated from said central voltage by an

5   amount corresponding to 2/5 or less of an amplitude of
said alternate-current driving voltage signal set so
as to provide a maximum gradation level.

10

      10. A liquid crystal display device as
claimed in claim 8, wherein said direct-current source
produces said common voltage such that said common

15   voltage is deviated from said central voltage by an
amount corresponding to 1/20 or less of an amplitude
of said alternate-current driving voltage signal set
so as to provide a maximum gradation level.

20

      11. A liquid crystal display device as
claimed claim 8, wherein said driving circuit produces

25   said alternate-current driving voltage signal such
that said central voltage is substantially zero volt.

30

      12. A liquid crystal display device as
claimed claim 8, wherein said driving circuit produces
said alternate-current driving voltage signal such
that said central voltage is offset from zero volt.

35

1   13. A liquid crystal display device as claimed in claim 8, wherein said direct-current source produces said common voltage such that a fluctuation of a leakage light, caused by a disclination induced

5   in said liquid crystal layer by a lateral electric filed, is 10% or less.

10

        14. A liquid crystal display device as claimed in claim 8, wherein said direct-current source produces said common voltage such that a flow of liquid crystal molecules, caused in said liquid

15   crystal layer by a disclination induced in said liquid crystal layer by a lateral electric field, has a velocity of 80 µm or less per an interval of 24 hours.

20

        15. A liquid crystal display device as claimed in claim 8, wherein said liquid crystal layer is formed of a low-voltage liquid crystal.

25

        16. A liquid crystal display device as

30   claimed in claim 8, wherein said auxiliary electrode extends along an edge of said conductor pattern, said lqiuid crystal display device thereby forming an H-type Cs liquid crystal display device.

35

1   ABSTRACT OF THE DISCLOSURE

      A liquid crystal display device includes a
d.c. voltage source for producing a common voltage
such that the common voltage is substantially equal to
5   a central voltage of a bipolar voltage signal.

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【書類名】　図面

【図１】

FIG 1

従来の液晶パネルの構成を示す平面図

10

11_1　11_2

G_1　D_1　D_2

Cs　Cs　Cs　Cs

Cs

P_2　P_1　P_3

11_3　11_4

G_2
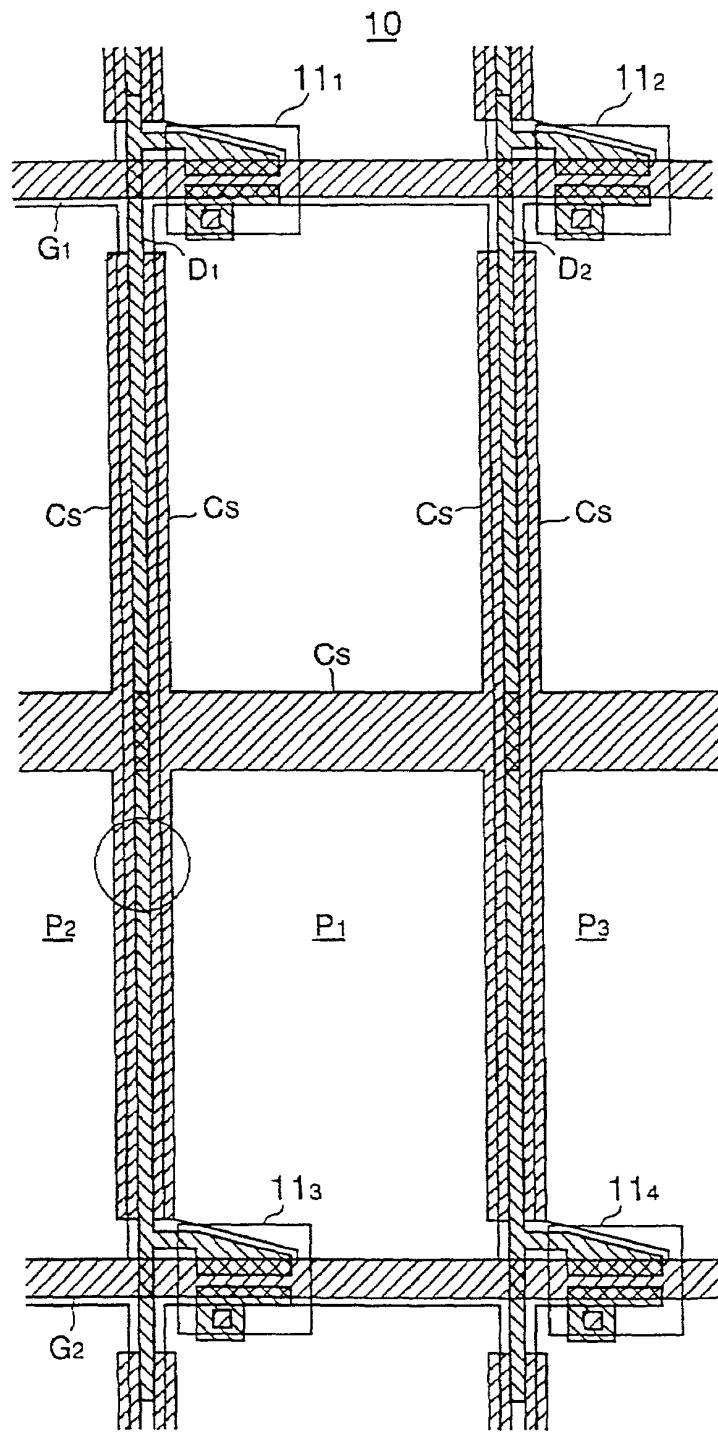
【図2】

FIG 2

従来の液晶パネルの構成を示す断面図
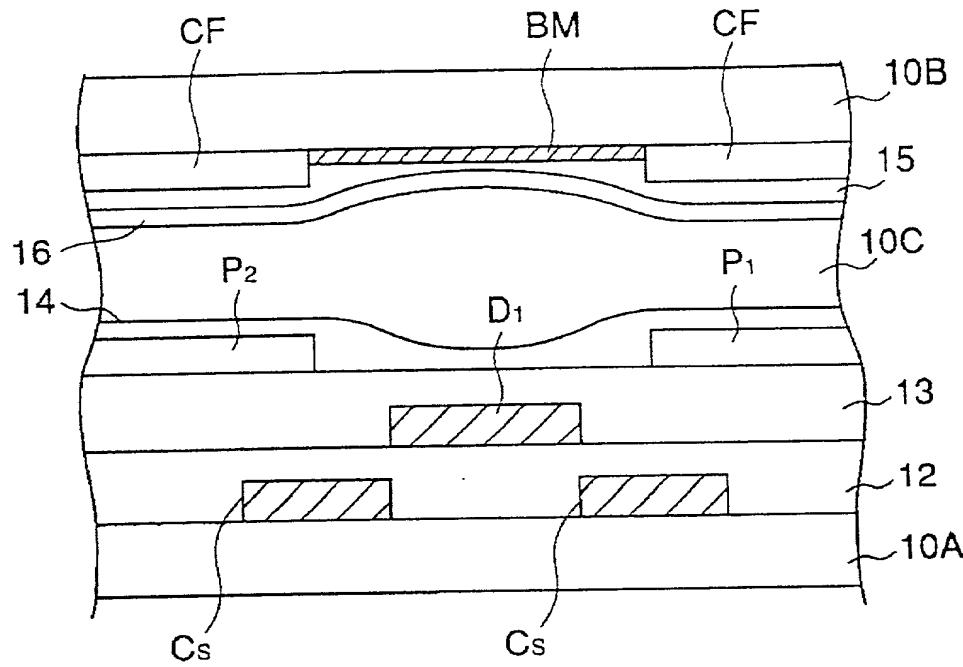
【図３】

従来の駆動電圧信号の例を示す波形図

FIG 3
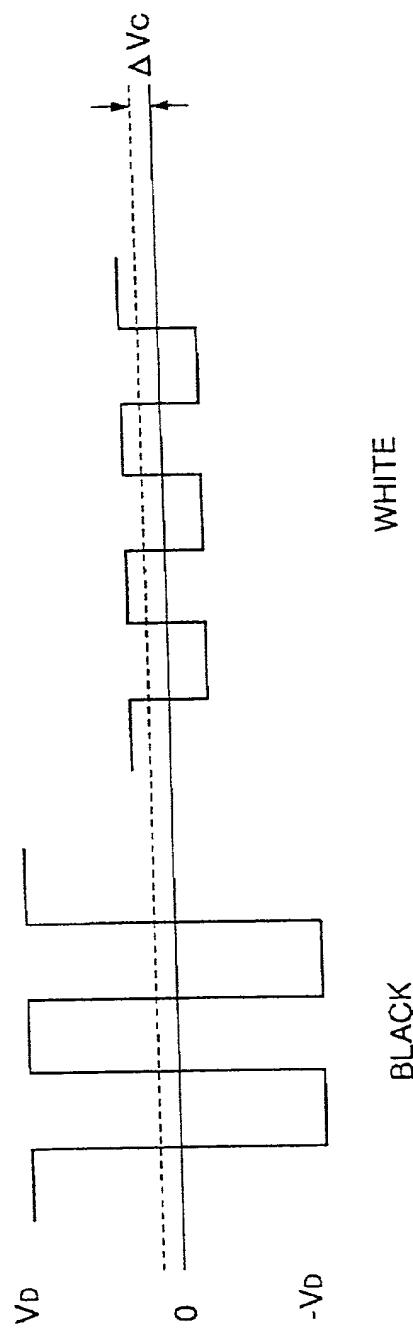
【図４】

(A),(B)は、従来の駆動方式における液晶層中の電気力線の
分布およびこれに伴う液晶分子の配列を示す図

↓　↓　↓　↓　LEAKAGE LIGHT
ドメインによるもれ光

FIG 4A (A)

VD=5V

ITO

ITO

0

Cs　D　Cs

0　　　　　40(μm)　　　　160

FIG 4B (B)

VD=-5V

ITO

ITO

0

Cs　D　Cs

0　　　　　40(μm)　　　　160
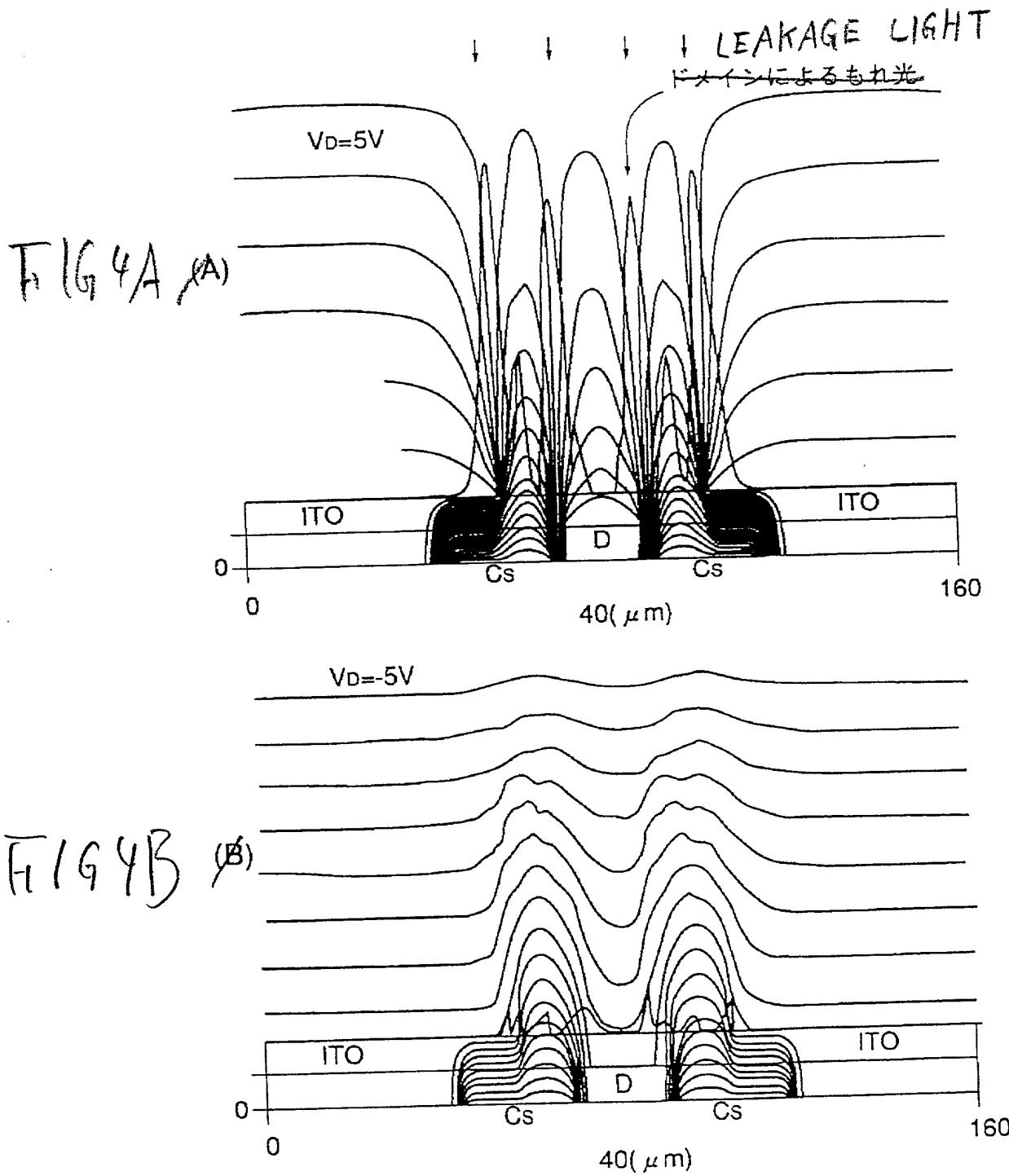
【図5】

FIG5

本発明の一実施例による液晶表示装置の構成を示す図
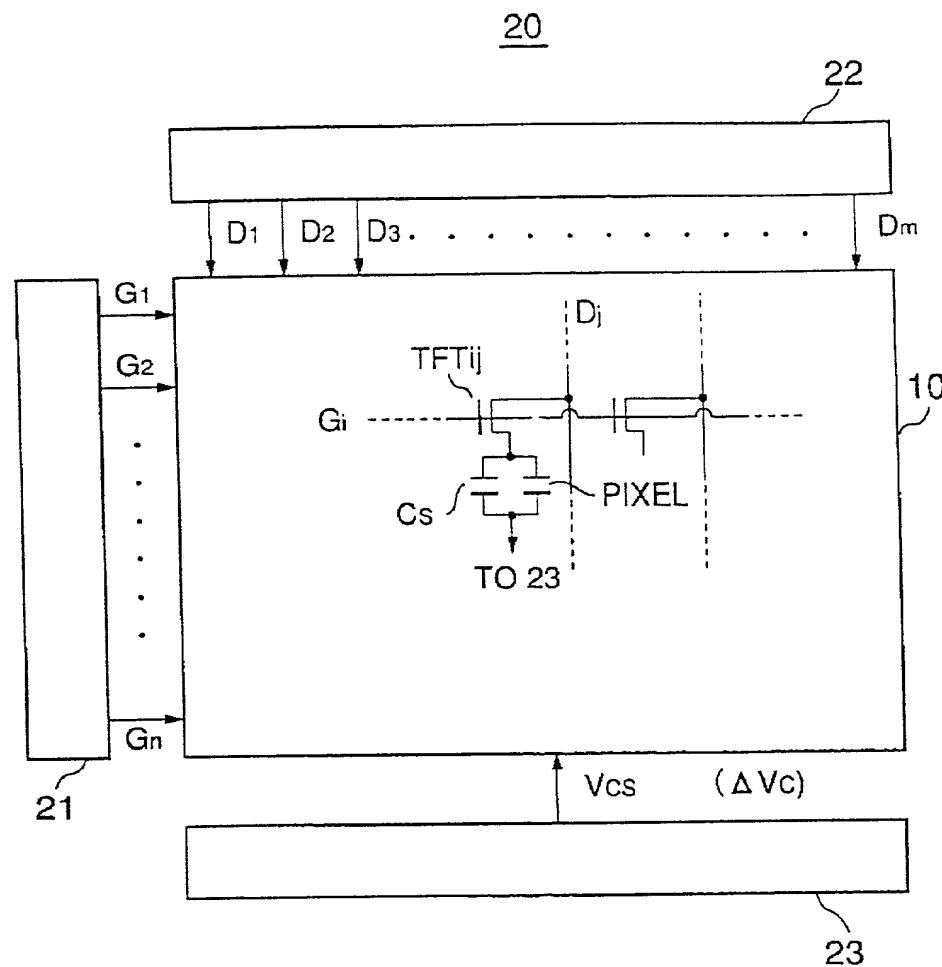
【図６】

(A),(B)は、本発明による液晶表示装置の駆動方式を使った場合の、
液晶層中の電気力線の分布およびこれに伴う液晶分子の配列を示す図

FIG6A (A)

VD=5V

ドメインによるもれ光

LEAKAGE LIGHT

ITO

ITO

0

Cs

D

Cs

0

40(μm)

160

FIG6B (B)

VD=-5V

ITO

ITO

0

Cs

D

Cs

0

40(μm)

160
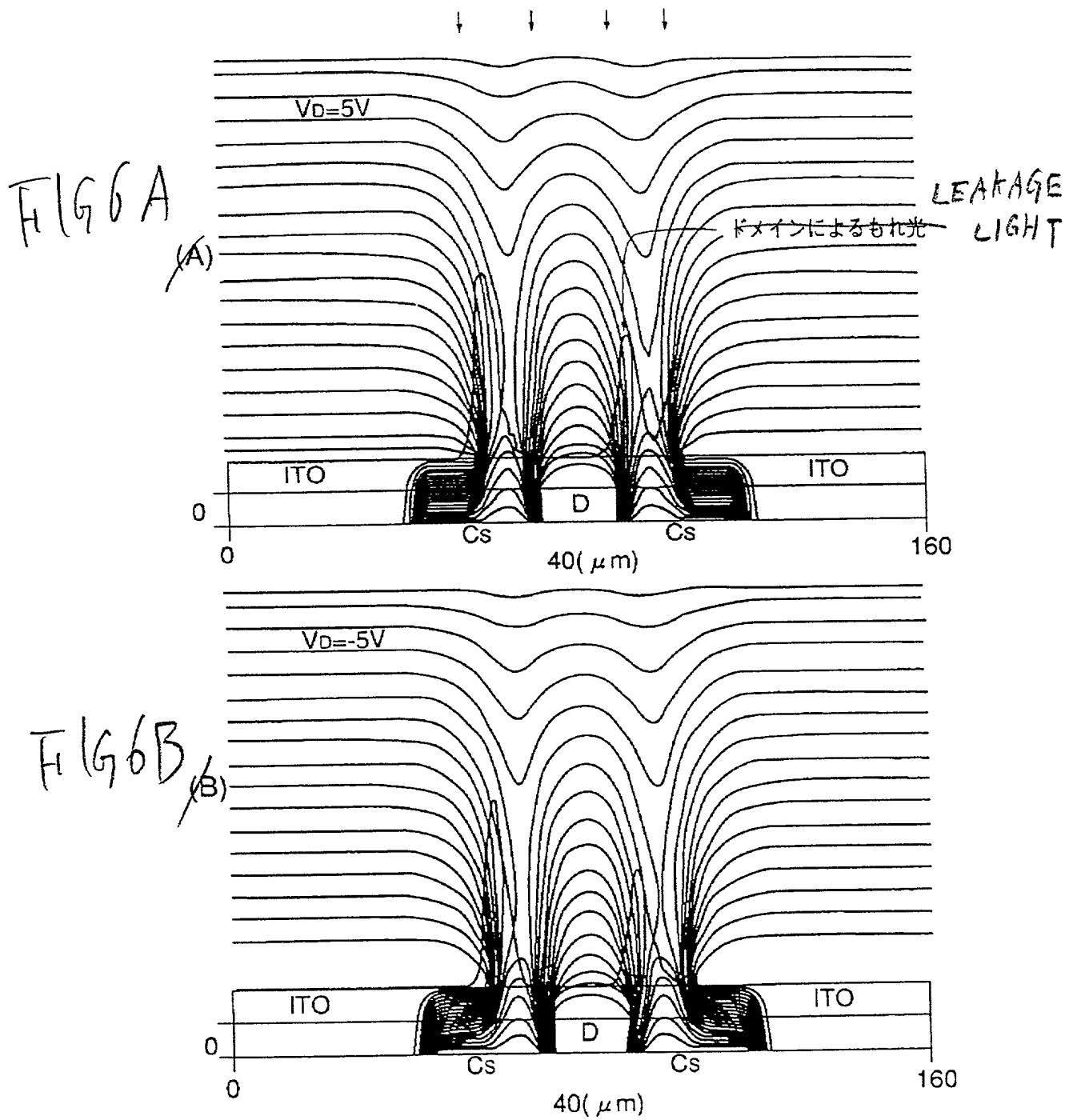
【図7】

本発明一実施例による、最適なコモン電圧の範囲を示す図

FIG7
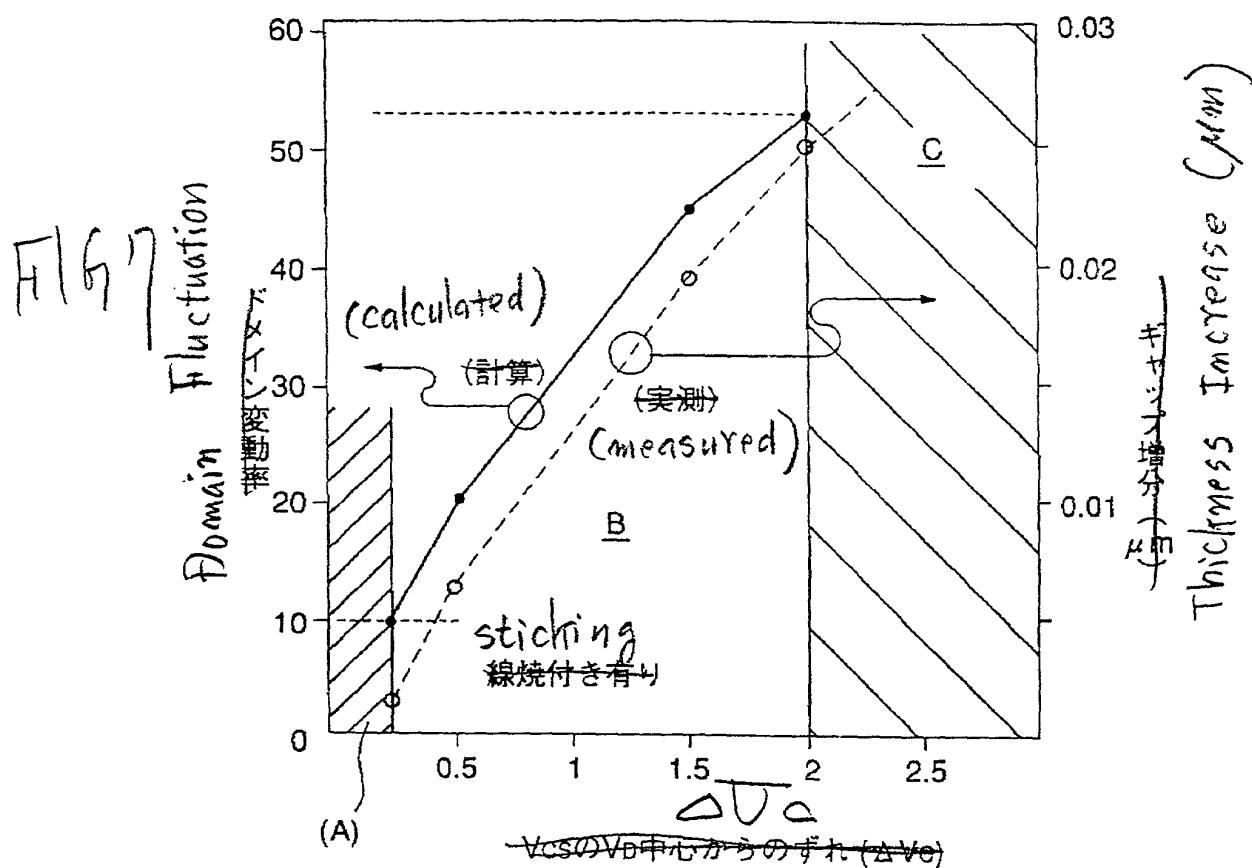
【図8】

別の駆動電圧信号の例を示す波形図

FIG8
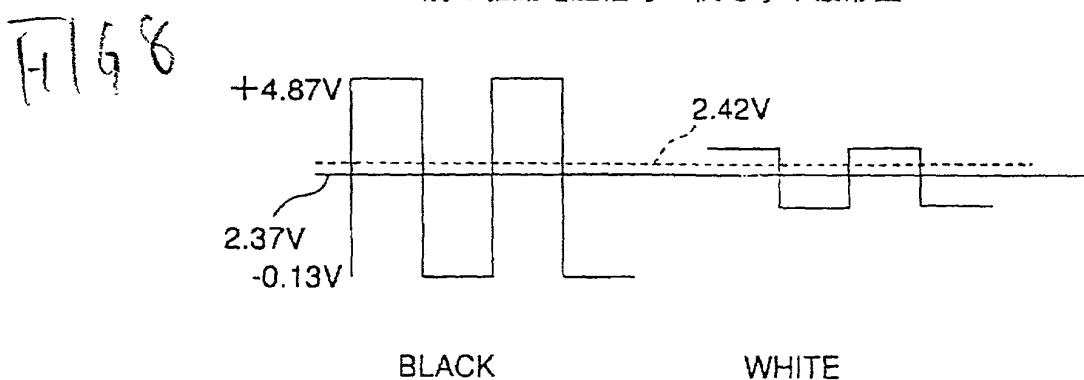
【図9】

FIG 9

図8の駆動電圧信号における最適コモン電圧を示す図

OPTIMUM COMMON VOLTAGE (V)

PANEL
パネル
◆ A
■ B

黒 ← 階調 → 白 WHITE

BLACK　　　GRADATION

PTO/SB/106 (8-96)
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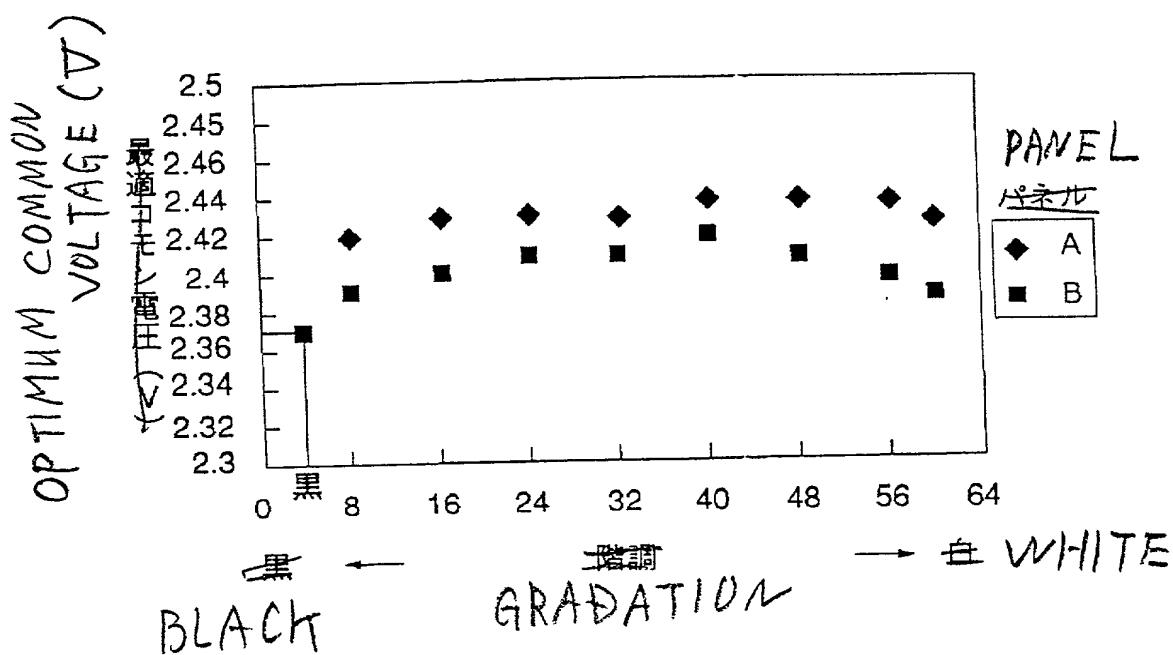
Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

DRIVING OF A LIQUID CRYSTAL DISPLAY DEVICE

上記発明の明細書（下記の欄でx印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☐ __月__日に提出され、米国出願番号または特許協定条約国際出願番号を_____とし、（該当する場合）_____ に訂正されました。

☐ was filed on _____ as United States Application Number or PCT International Application Number _____ and was amended on _____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

Priority Not Claimed
優先権主張なし

Pat. Appln. No.10-374813	Japan	28/December/1998	☐
(Number)	(Country)	(Day/Month/Year Filed)	
（番号）	（国名）	（出願年月日）	
(Number)	(Country)	(Day/Month/Year Filed)	☐
（番号）	（国名）	（出願年月日）	

私は、第３５編米国法典１１９条 (e) 項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

| (Application No.) | (Filing Date) | (Application No.) | (Filing Date) |
| （出願番号） | （出願日） | （出願番号） | （出願日） |

私は、下記の米国法典第３５編１２０条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約３６５条 (c) に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第３５編１１２条第１項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第３７編１条５６項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

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(Application No.)	(Filing Date)	(Status: Patented, Pending, Abandoned)
（出願番号）	（出願日）	（現況：特許許可済、係属中、放棄済）
(Application No.)	(Filing Date)	(Status: Patented, Pending, Abandoned)
（出願番号）	（出願日）	（現況：特許許可済、係属中、放棄済）

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第１８編第１００１条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(Declaration and Power of Attorney for Patent Application—Japanese Language Declaration (PTO/SB/106)

Japanese Language Declaration
(日本語宣言書)

委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named Inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith *(list name and registration number)*

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